



## **NASA STTR 2012 Phase I Solicitation**

### **T13 Ground and Launch Systems Processing**

The goal of this topic is to provide a flexible and sustainable US capability for ground processing as well as launch, mission, and recovery operations to significantly increase safe access to space. The Ground and Launch Systems Processing topic consists of four technology subareas, including: technologies to optimize the operational life-cycle, environmental and green technologies, technologies to increase reliability and mission availability, and technologies to improve mission safety/mission risk. The primary benefit derived from advances in this technology area is reduced cost, freeing funds for other investments.

## **Subtopics**

### **T13.01 Risk Engineering, Sciences, Computation, and Informed Decisions**

**Lead Center:** JSC

**Participating Center(s):** KSC

Human spaceflight missions in the early twenty-first century are still inherently complex and risky. While it takes a very talented and courageous flight crew to achieve a mission's objectives, it takes many more people on the ground to plan, prepare, and support the flight crew during the mission to ensure the safety of the crew and the success of the mission. For every human spaceflight mission, many decisions are made before each mission and more decisions are made during the mission in responding to changes in the environments or space vehicle systems. As in many other complex operations in harsh environments on Earth, labor-intensive information research and analyses is necessary to weigh the benefits versus the risks of each alternative in order to make accurate risk-informed decisions. Often these decisions need to be made in a short period of time before space vehicle systems are out of consumables or the risk of continuing the mission becomes unacceptable. Sometimes a decision that reduces risk in one limited perspective or frame of reference inadvertently increases system-level or end-to-end mission risk due to impacts that were not foreseen due to limited human ability to consider and assess all relevant data.

This STTR subtopic seeks to advance the state-of-the-art in knowledge management, information management, information technology, and artificial intelligence leading toward the ability for computer systems to assist humans in timely and correctly identifying, quantifying, characterizing, mitigating, and communicating risks to inform decision makers of risks before the decisions are made. Application of advanced computer-based decision support technologies to identify and assess relevant data, identify alternatives, and model consequences will significantly reduce the cost of development, deployment, and sustainment of complex space systems and significantly increase

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safety of crew during space missions. Below are some examples of technologies that would be appropriate for this sub-topic:

- *Timely Risk Identification* - For several decades, the Failure Modes and Effects Analysis has been used to identify risks inherent in space system designs. Analysis results are frequently not available until the system design has matured to the point where it is ready for final development, test, and or deployment. Changes late in the design lifecycle often cannot be accommodated due to significant schedule delay and cost increase. Although designing out hazards is the most effective and preferred means of control, mitigations for identified risks at this time are usually limited to procedural controls which require recurring attention throughout the operational phase. This often results in operational complexity, higher risk, and higher sustaining cost. An automated failure modes and effects simulation technology would be a game-changer by identifying safety and technical risks of the design early and quickly so that design changes or trades may be made to eliminate these risks at a much lower lifecycle cost and significantly improve safety and system reliability.
- *Risk-Informed Decision Making* - As space systems become more complex and human space exploration destinations get farther away from Earth, the flight crew may be forced to make timely decisions in responding to imminent hazardous conditions without the assistance of the ground crew. Risk-informed decision support technologies would assist the flight crew by suggesting possible actions that have the highest probability of success.
- *Context-Based Software Risk Modeling* - Space system designers are considering incorporating or increasing levels of automation in their systems to achieve a sustainable human space exploration program. Although the desired outcome is a net reduction of overall mission risk, more automation will result in increasing the complexity of the software systems, and thus increase the proportion of risk attributable to software faults as a component of system risk. NASA is seeking Context-Based Software Risk Model technologies to address the risks of software required functionality that would be compatible and consistent with the standard Probabilistic Risk Assessment methodology now employed by NASA. An effective integration of the PRA and CSRM techniques would facilitate comparative evaluations of automation design options for effectiveness in reducing mission risks.